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Abstract

CORROSION BEHAVIOUR OF STEELS IN CO_2/CO ATMOSPHERES

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The reactions of mild, low alloy and stainless steels with CO_2/CO atmospheres have been studied in support of the development of power reactors cooled by carbon dioxide.

Protective oxide films have been formed on mild and low alloy steels in CO_2 based environments at temperatures up to 550°C, although under some circumstances the films lost their protective character and the reaction rate increased markedly. Film breakdown could be postponed for a considerable time (e.g. 20,000h) and could be either general or localised. It was associated with temperatures > 350°C, high pressures (i.e. 14.6 atm), the presence of water vapour and to a lesser extent carbon monoxide. The behaviour of a given steel was often inconsistent with respect to breakdown; no correlation could be found with steel composition although rimming steels were most susceptible to localised breakdown.

A basic study of the oxidation and carburisation of a 20 Cr/25Ni/Nb stainless steel (fuel element canning material for the Advanced Gas Cooled Reactor at Windscale (WAGR)) has been carried out in pure CO_2, CO and mixtures of these gases at 600-850°C. Thin protective oxide films were formed in all instances.

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Carbon transferred from the gas phase during film growth readily passed through the oxide into the steel whilst carbon deposited on the surface of a preformed oxide film diffused only slowly during a subsequent anneal in an inert atmosphere. The penetration of the carbon into the steel was determined and at temperatures $\geq 750^{\circ}C$ a maximum up to 75μ from the oxide/metal interface was found in the carbon concentration-penetration curve.

The oxidation of WAGR fuel element cans has been studied under simulated reactor operation and fault conditions involving a temperature excursion and ingress of steam and air into the coolant circuit. The behaviour was satisfactory for protracted periods in CO_2 up to $750^{\circ}C$, but at higher temperatures loss of fin profile occurred which could adversely affect the heat transfer properties of the cans. The behaviour was not significantly affected by total pressure of additions of CO, H_2O or air to the gas.